Warren J. Baker Endowment

for Excellence in Project-Based Learning

Robert D. Koob Endowment *for Student Success*

FINAL REPORT

Final reports will be published on the Cal Poly Digital Commons website (http://digitalcommons.calpoly.edu).

I. Project Title

Unbreakable Black Holes Show the Solidity of Spacetime

II. Project Completion Date

Ongoing

III. Student(s), Department(s), and Major(s)

(1) Laura Fleischman

(2) Physics

(3) Physics

IV. Faculty Advisor and Department

Dr. Scott Fraser, Physics

V. Cooperating Industry, Agency, Non-Profit, or University Organization(s)

California Polytechnic State University, San Luis Obispo

VI. Executive Summary

We investigated a highly complex and mesmerizing system called a black string, which is simply a cylindrical stack of black holes. The black string system moves and changes in time, and the endpoint of this system remains an important unsolved problem in general relativity.

Since we are not currently able to study a black string directly (in a lab), we modeled our system as a viscoelastic fluid which enabled us to make strong predictions in the behavior of the black sting. In fact, we found that after becoming incredibly thin, the black string simultaneously becomes strong. This strength of the thin black string therefore suggests that the singularity within each black hole (which comprise the black string) will never be exposed.

Our conclusion of the black string endpoint upholds a long-standing hypothesis called Cosmic Censorship, which states that a singularity will never be observed from any point in spacetime. Hidden singularities have profound implications for our universe, such as preserving the predictive power of our physical laws, for example. In this way, we were able to use the intriguing system of the black string as evidence for the solidity of spacetime.

VII. Major Accomplishments

(1) Determining a likely endpoint of the black string system

(2) Upholding the Cosmic Censorship hypothesis

(3) Awarded a 2nd place prize at the CSU Student Research Competition

VIII. Expenditure of Funds

No funds were used since they were intended to cover publication fees, however our draft of a paper summarizing our results is still in progress.

IX. Impact on Student Learning

The opportunities I was awarded during my time at Cal Poly were responsible for sparking my interest in physics research. My experiences have allowed me to grow beyond an undergraduate student and into a contributing member of the scientific community. Through the invaluable guidance of my mentor Dr. Scott Fraser, I learned lessons and methods that could only be acquired outside of a classroom. Dr. Fraser helped me articulate my unique point of view and channel my thoughts and ideas through a physical and mathematical framework. Years of hard work and dedication to my research topic cultivated confidence in my abilities and pushed me towards the next level of my career.

I am currently pursuing a graduate degree in physics at San Diego State University. Due solely to my participation in undergraduate research, I am now equipped with skills that allowed me to attain a research position with the head of the physics department on MRI image reconstruction. The abstract and theoretical nature of my undergraduate research expanded my level of thinking so that I am now comfortable with new abstract concepts such as manipulation of k-space. I am overwhelmed with gratitude for my previous research experience which pushed the boundaries of our understanding of the physical universe. I am now motivated to continue to push the boundaries and deepen our understanding of medical physics.